Carbon Monoxide Detection & Schools

Frequently Asked Questions

What is carbon monoxide?

Carbon monoxide (CO) is a colorless, odorless, tasteless, poisonous gas that is produced by the incomplete burning of various fuels, including coal, wood, charcoal, oil, kerosene, propane, and natural gas. Equipment powered by internal combustion engines—such as cars, portable generators, lawn mowers, and power washers—all produce carbon monoxide.

Through the normal process of respiration, oxygen enters the lungs and is transported by hemoglobin in the blood to various organs and tissues in the body such as the heart and brain. When CO is inhaled, it enters the bloodstream and attaches to hemoglobin forming the COHb molecule. COHb reduces the ability of the blood to carry oxygen to vital organs by preventing the oxygen molecule from attaching to hemoglobin.

What are the symptoms of carbon monoxide poisoning?

Because carbon monoxide has no odor, color, or taste and is otherwise undetectable by human senses, people may not realize they are being exposed to the “silent killer.” Detrimental health effects depend on the length of exposure, blood concentration levels, and personal health conditions.

Due to their size, children are particularly vulnerable to elevated levels of CO and therefore poisoning can occur more rapidly in them than adults.

The symptoms of CO poisoning at low to moderate concentrations are similar to the flu and include—

- Headaches
- Dizziness
- Sleepiness
- Nausea
- Shortness of breath
- Mental confusion
- Disorientation
- Vomiting

At high concentrations in the blood, CO can cause—

- Cognitive impairment
- Loss of muscle coordination
- Loss of consciousness
- Coma
- Death

The U.S. Centers for Disease Control and Prevention (CDC) estimates that more than 400 people die in the U.S. from accidental CO poisoning each year. In addition, over 20,000 are injured or suffer illness from CO poisoning each year. Because symptoms are similar to the flu, CO deaths and injuries have been “grossly underreported” and, according to estimates, actual deaths may exceed 2,000. Even when there are not deaths, long term effects on the nervous system and heart can occur in as many as 40% of the cases.

What are common or potential sources of carbon monoxide in a school setting?

There are several potential sources of carbon monoxide that could be present in a school setting, including—

- Heating systems (HVAC – gas, oil fired, central and unitary equipment)
- Gas-fired appliances (e.g., ranges, ovens) found in kitchens and cafeterias
- Gas-fired clothes washers and dryers
- Gas-fired water heaters and boilers
- Vehicles left running in a loading dock
- Use of gas-fired power tools in a school building (e.g., by janitorial staff, in shop classes)

Exposure of students and school personnel to CO would be determined by their proximity to the CO-emitting source and/or the configuration of the building's HVAC systems.

How often do carbon monoxide exposure incidents occur in public schools?

The National Fire Protection Association (NFPA) conducted an analysis of non-fire CO incidents reported for the year 2005, which showed 260 total CO incidents reported nationwide in educational occupancies. Of these, 150 incidents occurred in occupancies for preschool through grade 12.

However, it is difficult to quantify the exact number of CO incidents in schools. Due to the fact that carbon monoxide affects each individual differently and symptoms of exposure mimic those of common ailments such as the flu, it is highly probable that the number of CO exposure incidents has been underreported. The number of CO incidents in schools likely will rise over the coming years, particularly as school buildings and their infrastructure age.

Are older school buildings more likely to experience carbon monoxide leaks?

Common perception seems to dictate that older school buildings likely contain older fossil fuel-burning furnaces, boilers, appliances, etc. As equipment ages, the potential for malfunction increases, particularly if they are not routinely inspected and properly maintained.

How much does it cost to install carbon monoxide detection systems in schools?

The cost will depend on the type of carbon monoxide detection and warning equipment installed. Generally, it would be less expensive to install single- or multiple-station alarms than system-connected carbon monoxide detectors, but detectors generally offer an advantage in that they are capable of sending signals to a remote supervising station or constantly attended onsite location, assuring continual monitoring, immediate notification, and timely response. System-connected detectors may either be part of a stand-alone CO detection control or be combined with an existing fire alarm system or security system. For commercial occupancies such as schools, combining system-connected CO detectors with an existing fire alarm system is typically done. To that end, the cost of installing CO detection in existing occupancies generally depends on whether or not it can be added to existing systems already in place.

NEMA has not surveyed its member companies to determine the costs of the CO alarms and detectors (and associated systems) they manufacture, nor has NEMA performed any economic analysis that allows for an official industry estimate. However, an installed CO detector—based on some unofficial estimates—likely falls somewhere in the vicinity of $275 per unit for a system-connected CO detector. This would include the detector, conduit, wire, labor, etc. Single- and multiple-station alarms presumably would cost less than this amount.

It is critical to stress that this is a very rough ballpark estimate; it is not the product of specific and detailed market analysis and should not be considered as an absolute. Costs would vary depending on the location, size of facility, number of detection units needed, etc. Any per unit costs would be multiplied by the number of units needed to outfit the school to ensure compliance with applicable laws and code requirements.

What are the key differences between carbon monoxide alarms and carbon monoxide detectors?

Most carbon monoxide alarms and detectors available on the market are listed by an independent, nationally recognized testing laboratory (NRTL) accredited by the U.S. Occupational Safety and Health Administration (OSHA) to comply with one of the two product standards published by Underwriters Laboratories, Inc. (UL). Such standards are developed according to the standards development guidelines adopted by the American National Standards Institute (ANSI).

Carbon monoxide alarms can be single- or multiple-station units that detect carbon monoxide and are either hard-wired into the building's AC power, operated by a battery, or plugged-in to an electrical outlet (generally with battery backup). Single station alarms are detectors that incorporate a sensor, control components and an alarm notification appliance in one unit operated from a power source either located in the unit or obtained at the point of installation. Multiple station CO alarms are single station alarms capable of being interconnected to one or more additional alarms so that the actuation of one causes the appropriate alarm signal to operate in all interconnected alarms. All such alarms are listed for compliance with ANSI/UL 2034, *Standard for Single- and Multiple-Station Carbon Monoxide Alarms.*

Carbon monoxide detectors are devices connected to an alarm control unit having a sensor that responds to carbon monoxide. These system-connected carbon monoxide detectors and sensors generally are listed for compliance with ANSI/UL 2075, *Standard for Gas and Vapor Detectors and Sensors.*

In general, single- or multiple-station carbon monoxide ***alarms*****:**

- Are lower in cost per unit than CO detectors
- Do <u>not</u> have the capability of sending an alert to a remote supervising station or constantly attended onsite location, instead relying on individuals to hear and respond to alarms
- Must be replaced when the device reaches its end-of-life (typical life of sensor)
- Could be used as an alternative to CO detectors in existing construction in an effort to control costs

In general, system-connected carbon monoxide ***detectors*:**

- Transmit signals to an approved remote supervising station or constantly attended onsite location, allowing for timely notification and response to CO incidents
- Can be operated as a stand-alone system or combined with either a new or existing fire alarm system or security system
- Should be required in new construction
- Are higher in cost per unit than CO alarms
- Must be replaced when the device has reached its end-of-life (typical life of sensor)

For new construction, system-connected carbon monoxide detectors *should be required* as the cost is minimal when included in the initial planning and estimates. CO detection can be incorporated with other life safety systems.

For existing construction, system-connected CO detectors are *preferable* for the advantage they offer in being able to send alerts to constantly attended onsite locations or approved remote supervising stations. However, acknowledging budgetary constraints and the need to control costs, single- or multiple-station alarms may be considered as an alternative, provided someone will be in a position to hear and/or respond to them should they signal.

What is the life span of carbon monoxide alarms and detectors?

The life span of all commercially available carbon monoxide alarms and detectors range between 6 and 10 years because the CO gas-sensing element of the device is considered a limited-life component. Therefore, ANSI/UL 2034 requires the CO alarm to indicate an end-of-life audible signal that is different from the alarm signal. ANSI/UL 2075 requires the CO detector to send an end-of-life signal to the control unit and to the remote supervising station. The end-of-life signal is triggered either by an internal timer or by a self-diagnostic test.

What is National Fire Protection Association (NFPA) 720, and why should it be cited statute?

National Fire Protection Association (NFPA) 720 is the *Standard for the Installation of Carbon Monoxide Detection and Warning Equipment.* NFPA 720 covers the selection, design, application, installation, location, performance, inspection, testing, and maintenance of carbon monoxide detection and warning equipment, including single- and multiple-station carbon monoxide alarms and carbon monoxide detectors and their related systems and components.

The 2012 edition of NFPA 720 should be cited in statute because it provides a performance-based alternative to prescriptive location requirements, thereby giving greater latitude to the state agency/entity responsible for implementing and enforcing the requirements. Although previous versions of NFPA 720 required CO detectors to be located on the ceiling above permanently installed fuel-burning appliances and on every floor and in every HVAC zone in commercial buildings, it may not be necessary to install CO detection on every floor/every HVAC zone if the upper floors or other areas of the building are not connected by duct work or ventilation shafts to a room containing a fuel-burning appliance. To that end, the 2012 edition of 720 (section 5.8.5.3.2) permits a performance-based alternative that would allow the state agency latitude in determining precise location requirements. They could then choose to model the location requirements for schools after the current requirements in section 28.3.4.6 of the 2012 edition of NFPA 101, *Life Safety Code*, for CO detection in hotels as a basis:

- In the room containing a fuel-burning appliance (FBA)
- In sleeping rooms with a FBA
- Centrally located within occupiable spaces served by the first supply air register from a permanently installed FBA HVAC system
- Centrally located within occupiable spaces adjacent to a communicating attached garage

How are these product (ANSI/UL 2034 and ANSI/UL 2075) and installation (NFPA 720) standards promulgated? Why are they important?

The efficacy of voluntary national consensus standards such as NFPA 720, ANSI/UL 2034, and ANSI/UL 2075, and subsequent code provisions, are the leading edge of verification and durability of many products. Life safety codes and standards ensure that products meet crucial performance requirements.

The American National Standards Institute (ANSI) accredits U.S. voluntary consensus standards. The organization oversees the creation, promulgation, and use of thousands of U.S. standards, by accrediting the procedures of standards developing organizations, such as Underwriters Laboratories, Inc. (UL) and the National Fire Protection Association (NFPA). Accreditation by ANSI signifies that standards developers are consistently adhering to the "*ANSI Essential Requirements"* to ensure a collaborative, balanced, and consensus-based approval process. Key elements of the process include:

- Consensus must be reached by representatives from materially affected and interested parties
- Standards are required to undergo public reviews, during which period any member of the public may submit comments
- Comments from the consensus body and public review commenters must be responded to in good faith
- An appeals process is required

Codes and standards drafting and acceptance follow regular schedules of review that incorporate the best thinking and state of the art developments.

Would portable classrooms (e.g., trailers) need to have carbon monoxide detection equipment installed?

If the portable classroom is separate from the main school building (i.e., not connected via duct work or sharing a common HVAC system) and has no other potential sources of carbon monoxide (i.e., is all-electric), it likely would not need to have carbon monoxide detection equipment installed. The code enforcement official responsible for inspecting school facilities and ensuring compliance with all applicable laws and codes would make the determination of need.

Does any other state require the installation of carbon monoxide detection in schools?

Yes. In 2011, the State of Connecticut enacted a law (Public Act 11-248) to require the installation of carbon monoxide detection and warning equipment in all public and nonpublic schools in the state. The Connecticut requirements cover both new and existing construction. It

should be noted that the Connecticut law specifically requires system-connected CO detectors in new school construction but provides flexibility for existing schools to install single- or multiple-station CO alarms in lieu of system-connected detectors.

In 2012, the State of Maryland enacted legislation (HB 2, Chapter 39, and SB 173, Chapter 38) to require CO detectors to be installed in newly constructed and substantially remodeled public schools. The law requires that CO detectors must automatically transmit signals to an approved supervising station or constantly attended on-site location and must be installed per the requirements of NFPA 720-2009 or the state fire prevention code.

About NEMA:

NEMA is the association of electrical equipment manufacturers, founded in 1926 and headquartered in Arlington, Virginia. Its member companies manufacture a diverse set of products including power transmission and distribution equipment, lighting systems, factory automation and control systems, and medical diagnostic imaging systems. NEMA Signaling, Protection, and Communication Section members manufacture fire, smoke, and carbon monoxide detection and warning equipment.

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